Management likewise determined that the cost of the Annual Reports should in future be paid out of the yearly appropriation, thereby of course, considerably narrowing the possible amount of work to be done in the field. In spite of these drawbacks, however, the State-geologist succeeded, during his first year of office, in doing some useful work, and yet kept a sufficient balance to publish a bulky report with a quarto atlas of plates. His plan was to attack first of all those branches of inquiry which presented the greatest interest or had the closest bearing upon the industrial resources of the State. The ground was surveyed by counties, Mr. Broadhead himself taking a lion's share of the hard work. The two lead regions of Southwest and Central Missouri were likewise examined. Many analyses were also made of the ores, slags, coals, and other mineral substances sent up to the office. The Report which gave an account of these labours cannot fail to be of great service in the development of the mineral resources of the State. Mr. Broadhead is evidently exactly the kind of director needed to keep the Missouri Geological Survey in full activity and to satisfy the demands of a utilitarian legislature.

The oldest rocks in Missouri appear to be certain granites and other crystalline masses, on which lie somewhere about 3,000 feet of Lower Silurian strata, including representatives of the Potsdam, Black River, Birdseye, Trenton, and Cincinnati groups of other parts of the United States. Upper Silurian rocks are much more feebly represented, but Dr. Shumard has recognised beds probably equivalent to the lower Helderberg and Niagara groups. The Devonian groups of Hamilton and Onondago are still more sparingly developed, only about 100 feet of strata being referable to those horizons. The Carboniferous system, however, is well displayed, and contains the following groups :—

LOWER.	Upper coal-measures (poor in coal)	1,307 feet.
	Middle ,, (with 7 ft. of coal)	324 ,,
	Lower ,, (with 13 ft. 6 in. of coal) ...	250–300 ,,
UPPER.	Chester group (sandstone) from a few feet to ...	100 ,,
	St. Louis ,, (limestone), maximum	250 ,,
	Keokuk ,, (shale and chert), perhaps exceeding	200 ,,
	Encrinital or Burlington group	60 ,,
	Chouteau limestone	100 ,,
	Vermicular sandstone and shales	75 ,,
	Lithographic limestone	55 ,,

No later formations occur until we reach the "Drift. This consists of two divisions ; the lower, formed of dark blue clay, overlaid and interstratified with beds and pockets of sand sometimes inclosing remains of terrestrial vegetation ; the upper composed of stiff, tenacious, brown, drab, and blue clays, often mottled, and containing rounded granitic pebbles. Large boulders of crystalline rocks from a northern source occur in the lower division, up even to a height of 1,050 feet above the level of the Gulf of Mexico. Most of the observed boulders occur in the valleys. They diminish in numbers and size as they are traced southwards, the Missouri River seeming to limit their extension in that direction. Above these clays lies the "bluff," or loess, a very fine light brown siliceous marl, with occasional concretions of limestone. With sufficient consistency to weather out into perpendicular escarpments, this deposit forms a belt of hilly country receding ten miles from the river, and then changing into a stiff clay which may be part of the "drift." The low alluvial lands lie on what is termed the "bottom prairie," generally a dark tenacious clay, often containing concretions of bog-iron, and rarely beds of sand.

From the early part of last century lead and iron have been worked in Missouri. The mining industry of the State has gradually developed, and is now making rapid progress. In the year 1872, 13,550,135 pounds of lead were produced in the State. During the first six months of 1874, 5,050 tons of pig-lead were sent by railway into St. Louis. The yield of iron and zinc is likewise steadily increasing. Vast quantities of sulphate of baryta are said to be raised, and to be used in the improvement (that is, the adulteration) of white lead. A territory so richly stored with mineral wealth ought to be able to equip and maintain a sufficient staff for the thorough exploration of the geological and mineralogical structure of the ground, and for the formation of a museum where the rocks, minerals, fossils, and manufactured mineral products may be displayed, and made practically useful and instructive.

ARCH. GEIKIE

OUR ASTRONOMICAL COLUMN

DUN ECHT OBSERVATORY PUBLICATIONS, VOL. II.—In this handsomely-printed volume of two hundred pages we have the first portion of results of observations made during Lord Lindsay's expedition to the Mauritius on the occasion of the late transit of Venus, an expedition which for the care and forethought bestowed upon the arrangements and the excellence and completeness of the equipment, compares favourably with any of those fitted out by the various Governments which took part in the observation of this rare phenomenon.

It was upon the strong recommendation of the eminent Secretary of the German Transit of Venus Commission, Prof. Auwers, that Lord Lindsay was induced to take out a heliometer, and an instrument of this class, similar to those intended to be used in the Russian expeditions, was ordered in the spring of 1872 and completed in due time by the joint exertions of Messrs. Repsold, of Hamburg, and Messrs. Cooke and Sons of York. In the investigation of the constants of the instrument previous to the expedition, experience was obtained of the great precision to be attained in the measurement of angular distance between two stars by its means, and this experience led to a determination to take advantage of a near opposition of the minor planet Juno, occurring during the anticipated period of residence at the Mauritius, to investigate the solar parallax, from the diurnal parallax of the planet, by measuring its distance and angle of position with respect to a star, both morning and evening. On November 4 Juno in perigee was distant 1·029, and though the parallactic displacement in such case is considerably less than in a transit of Venus, or an opposition of Mars, it was believed that the great accuracy attained in measures with the heliometer would more than compensate for this disadvantage.

Vol. ii. of the publications of Lord Lindsay's Observatory is devoted to the discussion of the observations of Juno, preceded by a very detailed account of the instrument and its adjustments and of the methods adopted in determining its instrumental errors, as errors of scale divisions and errors of screw and of the method of observation and calculation of instrumental results. And in the event of criticism of any of the processes it must be stated that the whole of the work is so presented as to admit of future discussion, with any modification of plan that may be deemed advisable. It was originally intended that the observations should commence on October 10 and continue to the end of November. Circumstances, however, prevented so long a series of measures ; Lord Lindsay's yacht with the instruments did not arrive at the Mauritius until November 2, and it was not till November 10 that the first heliometric observations could be made. The first reliable series was obtained two evenings later, and from this time to November 30, observations were secured on twelve evenings and eleven mornings, some of them not being so complete as was desirable. It will thus be seen that Juno was past opposition before work could be commenced, and this first attempt to determine the solar parallax, through measuring the diurnal parallax of a minor planet with the aid of the heliometer, was consequently made under less favourable conditions than may

© 1878 Nature Publishing Group

be secured in future investigations of the same kind; nevertheless, it is certain that Lord Lindsay and Mr. Gill have been amply justified by the result in the confidence they placed upon the proposed methods of observation, and have proved that one means of determining the solar parallax, admitting comparatively of very frequent repetition, is comparable in point of accuracy with methods involving far greater difficulty and expense and chance of failure. In the correction of the equations of condition for errors in the tabular places of Juno, derived from observations at Greenwich, Washington, and Cambridge, U.S., it was found desirable to work upon two systems, the probabilities being rather in favour of the second. The definitive result for the mean solar parallax is 8″·77, according to the first system, and 8″·76 according to the second. To these values and their probable errors (± 0″·04) the authors do not attach high importance, indeed, a discordant value from observations on November 15 being included, they say, "if we were asked what we believe to be the most probable value resulting from the determination, we should reject this result; the values then become 8″·82 – first system; and 8″·81 – second system. At the same time we are aware that the rejection of any observation is quite unsound." In a longer series, however, it is probable, as they observe, that the single discordant value would have been counterbalanced by another.

So far as we know, this is the first application of the heliometer to observation in the southern hemisphere. We think it must be generally conceded by astronomers that Lord Lindsay and Mr. Gill have rendered an important scientific service in this introduction of the most accurate of measuring instruments in the investigation of the sun's distance, by a method admitting of such repeated confirmation. Three of the minor planets approach the earth in the present year within the distance at which Juno was observed at the Mauritius in 1874.

THE SATELLITES OF MARS.—Prof. Asaph Hall, to whom, as the discoverer of these bodies, the right of selection of names appertains has definitively decided for *Deimus* for the outer moon and *Phobus* for the inner one, agreeably as he mentions to the suggestion of Mr. Madan in these columns, founded on the lines in the "Iliad," which Pope thus renders:—

> "With that he gives command to *Fear* and *Flight*,
> To join his rapid coursers for the fight;
> Then grim in arms, with hasty vengeance flies,
> Arms that reflect a radiance through the skies."

THE DATE OF EASTER.—Easter Sunday falling on April 21, is considered late this year, and it is thirteen days after the mean date, but it is to be remarked that in no year since the introduction of the Gregorian calendar into England has the festival occurred on the latest possible date, April 25, though in two years, 1761 and 1818, it fell on March 22, which is the other limit. In 1886, Easter Sunday will fall on April 25, in the new or Gregorian style, for the first time since the year 1734, or eighteen years before this style was accepted in England. The only other occasion since the reformation of the Calendar by Pope Gregory XIII., upon which Easter has fallen on the latest possible date was in 1666, and after 1886 this will not again occur till 1943.

BIOLOGICAL NOTES

THE AGRICULTURAL ANTS OF TEXAS.—Mr. H. C. McCook has presented to the Academy of Natural Sciences of Philadelphia a memoir on the habits of these most curious and interesting ants (*Myrmica molefaciens*, Buckley = *M. barbata*, Smith). An abstract of the memoir will be found in Sheet 20 of the *Proceedings* of the above Academy (p. 299). The author encamped in the midst of a large number of the ant hills during the summer of 1877, and carefully studied the habits of the inmates; the spot selected was in the neighbourhood of Austin, Texas, upon the tableland to the south-west of the Colorado River and its affluent, Barton Creek. The limestone rock here and there cropped up, the soil was black and tenacious, varying in depth from a few inches to three feet. The formicaries were very numerous, and were to be found along roads, in open fields, and in the very streets, paths, gardens, and yards of Austin; indeed, one was even seen in the stone-paved courtyard of an hotel. They are commonly flat circular clearings, hard and smooth; a few have low mounds in the centre, composed of bits of gravel of one or two grains' weight; the clearings vary in width from twelve to two or three feet. From each, roads three to seven in number, diverge into the surrounding herbage. These are often of great length, and during the working hours are thronged by the ants going and returning. The ants take their siesta during the meridian heat of the sun, generally stopping work about twelve, and not returning to it until two or three o'clock. The seeds collected were always taken from off the ground, they were chiefly seeds of small Euphorbiaceous and Rubiaceous plants, and of grasses. The ants proved to be true harvesters. The seeds were carried into the granaries through the central gates. They were shelled, and the hulls were carried out and deposited in refuse heaps, which, when carefully searched, yielded no perfect fruits. They seemed to be most fond of the grass called *Aristida stricta*, and it even seems possible that they sow this for themselves, though the author does not commit himself to this as a fact. The interior economy of the ant-hill is fully described. Here it may be noted that the ants are clever in attack, that their "sting" is as bad as a wasp's, and that they are so well versed in the science of war, that they would have been more than a match for Mr. McCook, had he not himself employed a small army (of two men) to fight with those ants that would fight with him while he was pulling their granaries, their nurseries, and their queen's palace to pieces, in order to let us know all about them. Prof. Leidy made some remarks on this paper, adding that he had studied the habits of an allied species (*M. occidentalis*) which he had met with during a summer in the Rocky Mountains. The habits of this species were very like those of the species described by Mr. McCook, but in addition Prof. Leidy mentioned that his species fostered a fine large Coccus for its saccharine production.

THE FIRST STAGES OF DEVELOPMENT IN PLANTS.—Great interest attaches to the earliest changes occurring after the fertilisation of the germinal cell or oösphere in plants; and the difficulty of the subject has taxed the ability of the best histological botanists. To satisfy the doctrine of evolution many students think it necessary to be able to trace homologies in the development of all stem-bearing plants. The latest investigation, which appears to carry the comparison further than has yet been attempted, is that of Mr. S. H. Vines, of Cambridge, who has diligently sought out and compared all the embryological evidence, derived from the writings of Hofmeister, Hanstein, Fleischer, Mettenius, Pringsheim, and many others. He shows that in all stem-bearing plants the germinal cell (that which is fertilised) divides into two portions, one of which gives rise to an embryonic tissue called suspensor, in higher forms, while the remainder alone produces the true embryo. This comparison is of especial interest in relation to mosses. In these plants it is the spore-capsule which is the product of the fertilisation of the germ-cell, and it is this capsule which corresponds to the whole leafy plant of a fern. Following out the analogy, the seta or stalk of the capsule in a moss corresponds with the part called "foot" in an embryo fern, and with the suspensor in flowering plants. Mr. Vines's paper is contained in the

© 1878 Nature Publishing Group